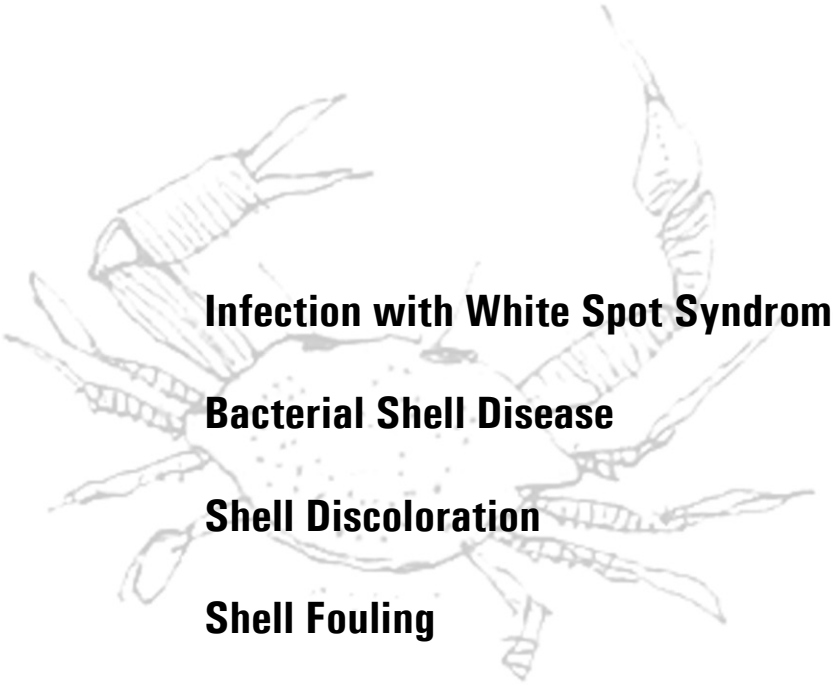
# Diseases in Juveniles and Adults



**Infection with White Spot Syndrome Virus**

**Bacterial Shell Disease**

**Shell Discoloration**

**Shell Fouling**

**Microbial Contamination of the Hemolymph**

**Gill Fouling with Debris**

**Algal Encrustation**

**Gill Commensals and Parasites**

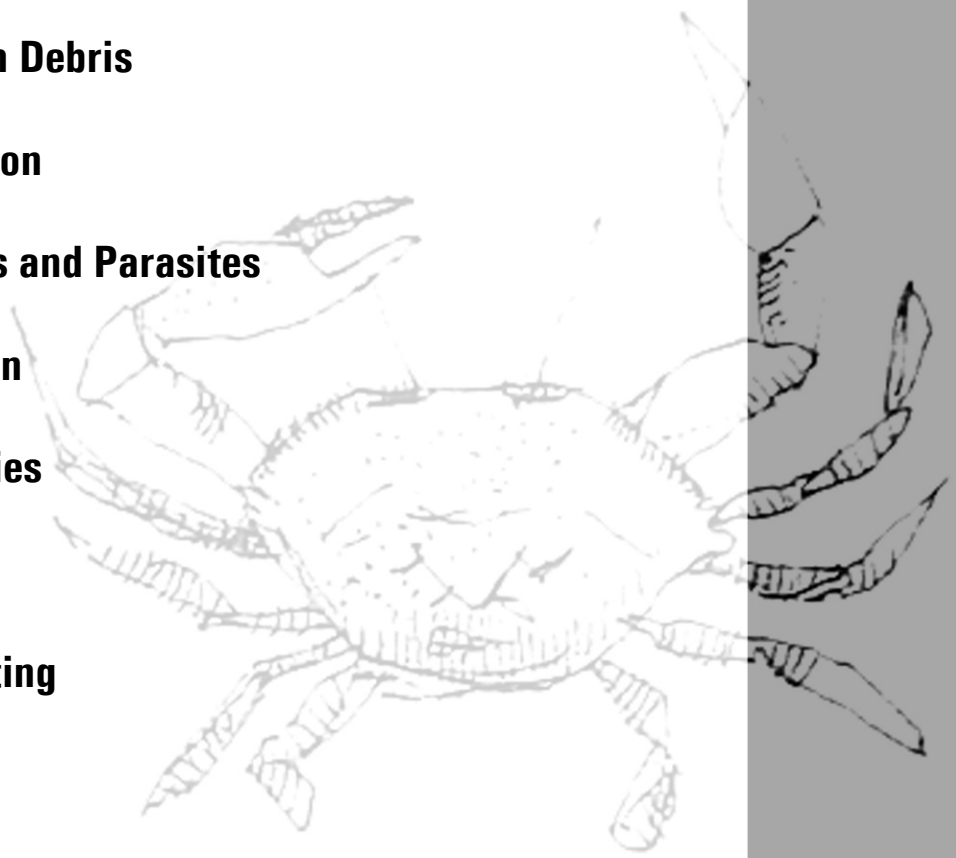
**Gill Discoloration**

**Blackened Ovaries**

**Egg Loss**

**Incomplete Molting**

**Loss of Limbs**



# White Spot Syndrome Virus (WSSV)

**Pathogen or Cause:**

WSSV is caused by a rod-shaped DNA virus belonging to genus Whispovirus. This virus is now widely distributed in crustacean culture systems and the wild. Crabs are known to be less susceptible compared with shrimps and all stages of crabs may carry WSSV without showing any disease sign.

**Effect on Crabs:**

- There are conflicting reports about mortalities of crabs due to WSSV
- Infected crabs become carriers of the virus and may introduce it to other rearing systems
- Given the carrier status of crabs, management decisions regarding polyculture with species highly susceptible to WSSV should be reconsidered

**Diagnostic Techniques:**

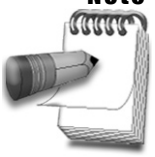
**Gross Observations (Level I):**

- Carrier crabs do not show any external signs

**Molecular Techniques (Level III):**

- Analyze tissue samples by Polymerase Chain Reaction (PCR) method
- Prepare appropriate samples as described in Appendix 1
- Obtain samples that will give a significant level of confidence when detecting the virus carrier status of specific samples. Use the table shown on Appendix 4 to determine sample sizes

**Note**



*WSSV is a disease reportable to the Office International des Epizooties (OIE) or World Organization for Animal Health. OIE is an intergovernmental organization with 166 members as of March 2004. Its mission is to guarantee the transparency of animal disease status world-wide. Each Member Country undertakes to report the animal diseases that it detects on its territory. The OIE then disseminates the information to other countries, which can take the necessary preventive action. The OIE collects and analyses the latest scientific information on animal disease control. This information is then made available to the Member Countries to help them to improve the methods used to control and eradicate these diseases.*

*Crustaceans, including crabs, are adversely affected by a number of diseases. The crustacean diseases and their etiological agents that are included in OIE's* Aquatic Animal Health Code *(the* Aquatic Code*) have restricted geographical range, have no therapeutic remedies or treatments, are potentially excludable, and are of significant social and economic importance. There are currently eight diseases of crustaceans listed by the OIE.*

*For more information about the OIE, log-in to www.oie.int*

**Methods of Prevention and Control:**

- Disinfect spawners to reduce microbial load and other substances that can entrap pathogens or their carriers
- Use de-chlorinated water (Appendix 5)
- Observe biosecurity in the rearing system, including natural food and feeds
- Quarantine and restrict movement and transfer of crustacean hosts and carriers
- Install screens and fences to ensure biosecurity of culture premises

## References

Chen LL, Lo CF, Chiu YL, Chang CF, Kou GH. 2000. Natural and experimental infection of white spot syndrome virus (WSSV) in benthic larvae of mud crab *Scylla serrata*. Dis. Aquat. Org. 40: 157-161

Supamattaya K, Hoffmann RW, Boonyaratpalin S, Kanchanaphum P. 1998. Experimental transmission of white spot syndrome virus (WSSV) from black tiger shrimp *Penaeus monodon* to the sand crab *Portunus pelagicus*, mud crab *Scylla serrata* and krill *Acetes* sp. Dis. Aquat. Org. 32: 79-85

## Web-based Resources

http://www.oie.int/eng/normes/fmanual/A_00046.htm

http://www.fao.org/DOCREP/005/X8485E/x8485e06.htm = this site provides a link to the "Beijing Consensus and Implementation Strategy"

# Bacterial Shell Disease

Abnormalities of the shell usually start with the appearance of fuzzy mats composed of a community of filamentous blue-green algae, bacteria, sessile, ciliated protozoans; saprophytic ciliated protozoans and some flagellates. Unaffected crabs possess shiny exoskeletons. Shell disease commonly starts on the dorsal areas, especially the carapace (Appendix 10) since frequent brushing of the ventral region with the sand substrate during burrowing may have a cleaning effect. Conditions during maintenance of broodstock in tanks may result to severe fouling leading to either shell perforation or parasite settlement. These are brought about by inappropriate holding conditions, overcrowding, and absence of environmental factors that would have prevented the dominance of fouling organisms. Once the integrity of the shell is damaged, portals of entry for secondary and opportunistic pathogens may be created.

**Pathogen or Cause:**

Chitinolytic or chitin-digesting bacteria which are either sucrose-fermenting or non-sucrose-fermenting vibrios identified as *Vibrio vulnificus, V. parahemolyticus, V. splendidus,* and *V. orientalis*. Majority of the strains associated with shell disease are within the Vibrionaceae, a common family of marine bacteria that is ubiquitous in the marine environment. The association of these bacteria both with lesions and with non-diseased crustaceans suggests that the natural flora is responsible for the shell disease lesions seen in these animals. Shell disease may also be induced by mechanical injury.

**Effect on Crabs:**

- Shell disease affects 100% of captive crabs after being held in tanks for three months, but is seldom found in newly-recruited crabs from ponds or the wild
- The condition seldom leads to mortality, but extensive shell erosion and perforation may create portals of entry for secondary bacterial or parasitic infections
- Around perforations of the shells are found small populations of saprophytic protozoans and nematodes, but not in the hemolymph

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Shell disease initiated by punctures and mechanical injuries inflicted during fighting shows blackening at the site of injury (Photo 1)
- Shell disease appears initially as discolored patches on the carapace (Photo 2), which later spread over the appendages (Photos 3 and 4)
- May cover more than 75% of the dorsal region of the shells (Photo 5). In severe cases, shell disease spreads to the ventral side of crabs causing extensive brownish to black discoloration (Photos 6-8)
- Many parts of the exoskeleton become soft and black as they lose the calcified tissue underneath
- These areas easily became perforated, exposing underlying tissues

**Microbiological Techniques (Level II):**

- Bacteria associated with shell disease can be easily cultured by streaking samples of affected tissues on Nutrient agar and TCBS (Appendix 4a). The bacterial population obtained in patches with shell disease can reach up to $10^7$ total bacteria per 0.1 g of sample, 50 - 75% of these are chitinolytic. Aside from chitinase, these vibrios also

possess the enzymes gelatinase and lipase, which are considered compounding factors that enhance shell degradation

**Histology (Level II):**

- Tissues just beneath shell disease show melanization typical of those undergoing inflammatory reaction (Photos 9-10; H&E × 100)

**Mode of Development:**

- It is quite probable that the microbiological aggregate formed on the shell provided a good environment for chitinolytic vibrios to settle causing gradual damage resulting in perforation
- Injury inflicted during handling and crowding, and exposure to pollutants are some of the predisposing factors implicated

**Methods of Prevention and Control:**

- Provide a sandy substratum of appropriate thickness under which the crabs could burrow. Provision of an optimum amount of substrate may not only reduce stress, but also reduce the build-up of fouling organisms on the crabs
- Regularly brush and wipe the dorsal region of the exoskeleton of crabs with cotton dipped in iodine solution to prevent fouling during captivity and to minimize the buildup of organisms, which provide a favorable substrate for the establishment of chitinolytic bacteria
- Where feasible, induced molting since the condition is shed with the old shell except when underlying tissues are severely damaged

## References

Baross JA, Tester PA, Morita RY. 1978. Incidence, microscopy and etiology of exoskeleton lesions in the tanner crab, *Chionoecetes tanneri*. J. Fish. Res. Board Can. 35: 1141-1149

Fisher WS. 1988. Shell disease of lobsters, pp. 236-239. In: CJ Sindermann, DV Lightner (eds). Disease Diagnosis and Control in North American Aquaculture. Developments in Aquaculture and Fisheries Science 17. Elsevier, Amsterdam

Getchell RG. 1989. Bacterial shell disease in crustaceans: a review. J. Shellfish Res. 8: 1-6

Lavilla-Pitogo CR, Marcial HS, Pedrajas SAG, Quinitio ET, Millamena OM. 2001. Problems associated with tank-held mudcrab (*Scylla* spp.) broodstock. Asian Fisheries Science 14: 217-224

Lio-Po GD, Lavilla-Pitogo CR. 1990. Bacterial exoskeletal lesions of the tiger prawn *Penaeus monodon,* pp. 701-704. In: Hirano R , Hanyu I (eds), The Second Asian Fisheries Forum, Asian Fisheries Society, Manila, Philippines

Porter L, Butler M, Reeves RH. 2001. Normal bacterial flora of the spiny lobster *Panulirus argus* and its possible role in shell disease. Mar. Freshwat. Res. 52: 1401–1405

Rosen B. 1970. Shell disease of aquatic crustacea. In: SF Sniesko (ed). A Symposium on Diseases of Fishes and Shellfishes. American Fisheries Society Special Publication 5: 409-415

Sindermann CJ. 1989. Shell disease in marine crustaceans – a conceptual approach. J. Shellfish Res. 8: 461-462

## Web-based Resources

http://www.frdc.com.au/about/index.htm = this is the download site of "Port Curtis Mud Crab Shell Disease – nature, distribution and management", specifically PDF1998-210

http://www.seafdec.org.ph/downloads/hilites2k3.pdf

http://crabstreetjournal.com/articles/shelldisease/message26526.html

http://crabstreetjournal.com/articles/shelldisease/index.html

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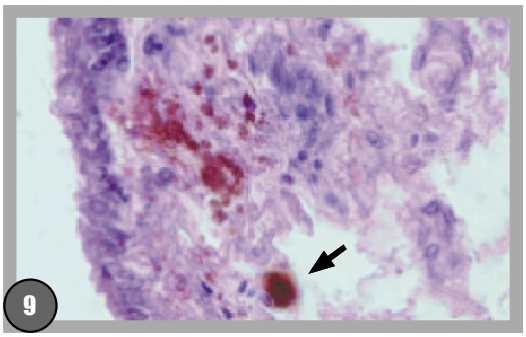
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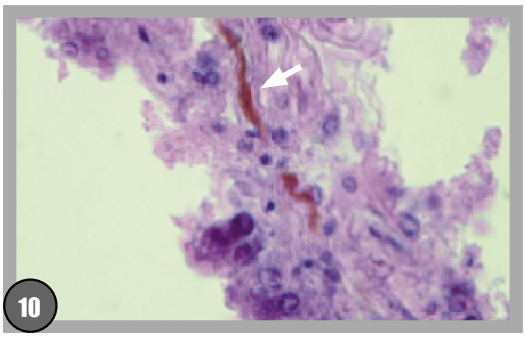
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# Shell Discoloration

**Description:**

Crab shells are covered by yellowish-brown (Photo 1) to reddish-brown (Photo 2) deposits. The deposits are more obvious on the whitish ventral side but easily comes off after scraping (Photo 2).

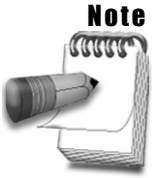
**Cause:**

Low soil pH and water pH. Acidic soil and water causes formation of iron precipitates on crab shells.

**Effect on Crabs:**

- Although shell discoloration *per se* has no effect on the calcareous shell, the factor leading to discoloration may adversely affect other organs like the gills and the eyes
- Exposure of crabs to acidic soil and water causes impairment of normal metabolism, leading to growth retardation and death

**Note**



*Very high pH levels in ponds can also cause mortalities, both because of the direct effect of the pH itself and because of the greater solubility of waste ammonia at high pH. High pH may also be due to dense phytoplankton blooms.*

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Presence of orange to brown deposits on the crab shell that easily comes of after light scraping (Photo 2; arrow)

**Methods of Prevention and Control:**

- Prepare ponds properly to avoid acid sulfate problems and use lime to correct soil pH. Refer to additional information about pond preparation and crab culture in the references below
- Submit soil samples for analysis (Appendix 11) to determine acidity and corrective action

**References**

Baliao DD, de los Santos MA, Franco NM. 1999. Mudcrab, *Scylla* spp., production in brackishwater ponds. Aquaculture Extension Manual No. 28, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines. 10 p

Baliao DD, de los Santos MA, Franco NM. 1999. Pen culture of mudcrab in mangroves. Aquaculture Extension Manual No. 26, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines. 10 p

Triño AT, Rodriguez EM, Coniza EB, Juanga BP. 1999. Mudcrab. Aquaculture Extension Manual No. 27, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines. 32 p

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# Shell Fouling

**Cause:**

The general body surface of the crab can serve as a substrate for many types of fouling organisms like filamentous bacteria and algae, and single or colonial protozoa. The presence of crabs in the culture system that are covered with algae or showing signs of not having molted may indicate either that culture conditions are poor or that the animals are not healthy. Shells of juveniles are usually shiny with regular bumpy irregularities on the surface (Photo 1). Healthy crabs preen to keep their shells clean. Crabs may fail to preen due to limitation of movement especially if they are kept in individual enclosures to avoid cannibalism (Photos 2 and 3). This leads to accumulation of fouling organisms composed of a mixture of microorganisms, algae and debris (Photos 4 and 5). Molting provides an opportunity to get rid of the old shell with its associated fouling organisms and repair whatever damage it has gone through during the intermolt period. Barnacles may also be found attached to the carapace and chelipeds of crabs (Photo 6). These organisms, though not causing mortality, may affect the mobility of the crabs in severe infestations due to the extra weight of the barnacles leading to longer intermolt period.

**Effect on Crabs:**

- In light infestation, none, especially if molting is regular
- Heavily infested crabs may be burdened by the additional load of fouling algae with the possibility of slowed-down movement or longer intermolt duration
- Heavy fouling on the shell surface can reduce the market value of crabs

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Crab shell has attached velvety greenish to brown algae or barnacles and other encrusting organisms (Photos 4-6)

**Methods of Prevention and Control:**

- Provide rearing conditions that allow normal behavioral patterns like burying in the sediment, hiding in rock crevices, night-time activity, and exposure to air. These behaviors impede fouling through mechanical abrasion, lack of access, and desiccation
- Provide adequate space for preening and movement
- Increase water movement to inhibit attachment of fouling oganisms
- Induce molting to temporarily get rid of these fouling micro-organisms
- Infestation by filamentous algae has been observed to occur in grow-out ponds with high transparency (above 40 cm). This problem can be reduced by encouraging phytoplankton growth to lower water transparency

**References**

Bauer RT. 2002. The ineffectiveness of grooming in prevention of body fouling in the red swamp crayfish, *Procambarus clarkii*. Aquaculture 208: 39-49

Becker K, Wahl M. 1996. Behavior patterns as natural antifouling mechanisms of tropical marine crabs. J. Exp. Mar. Biol. Ecol. 203: 245-258


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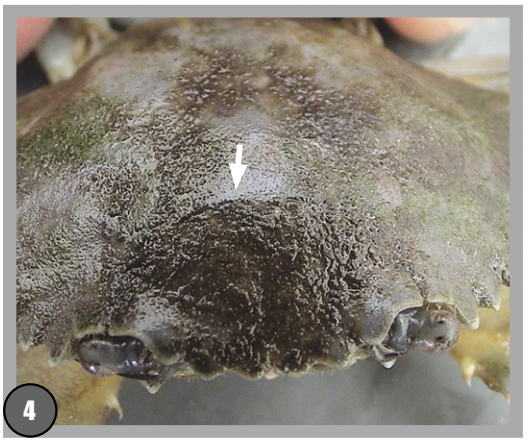
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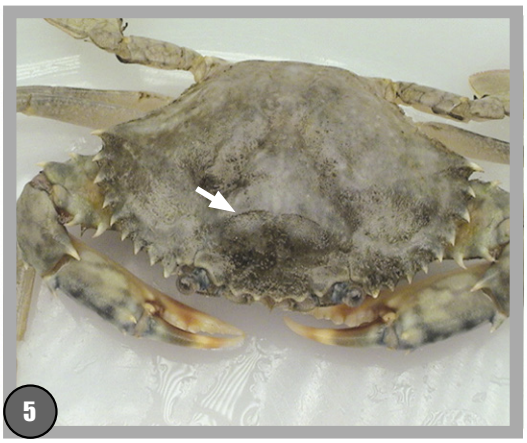
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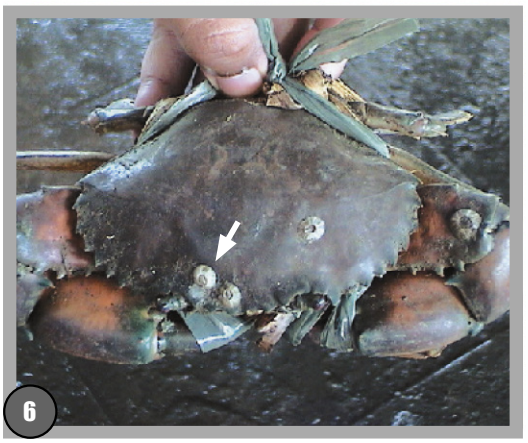
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# Microbial Contamination of the Hemolymph

**Pathogen or Cause:**

Crabs from the wild as well as those that have been kept in tanks for several months harbor mixed populations of bacteria in the hemolymph, mainly dominated by sucrose-fermenting vibrios. The associated *Vibrio* bacteria are ubiquitous in the marine environment.

**Effect on Crabs:**

- Unknown and poorly understood
- The presence of bacteria in the hemolymph of new recruits, where shell disease was not seen, shows that shell perforation is not necessarily a precursor to internal contamination
- The presence of bacteria in the hemolymph has also been reported in other crustaceans
- The bacteria could invade the hemolymph through abrasions in the cuticle of the crab, and multiplies in the blood or some unknown route
- The true prevalence of crabs with vibrios and other bacteria in the hemolymph is unknown

**Diagnostic Techniques:**

**Microbiological Techniques (Level II):**

- Draw hemolymph from the soft tissues at the joints of shell plates or chelipeds (Appendix 10) using a tuberculin syringe, and deliver at least 0.1 ml on prepared microbiological culture media by spread plate method (Appendix 4a)
- Observe for bacterial colonies after 24 – 48 h incubation at room temperature. The presence of off-white bacterial colonies on nutrient agar (Photo 1), and green and yellow bacterial colonies on *Vibrio* selective agar (Photo 2) indicate hemolymph contamination

**Methods of Prevention and Control:**

- Unknown

## References

Davis JW, Sizemore RK. 1982. Incidence of *Vibrio* species associated with blue crabs (*Callinectes sapidus*) collected from Galveston Bay, Texas. Appl. Environ. Microbiol. 43: 1092-1097

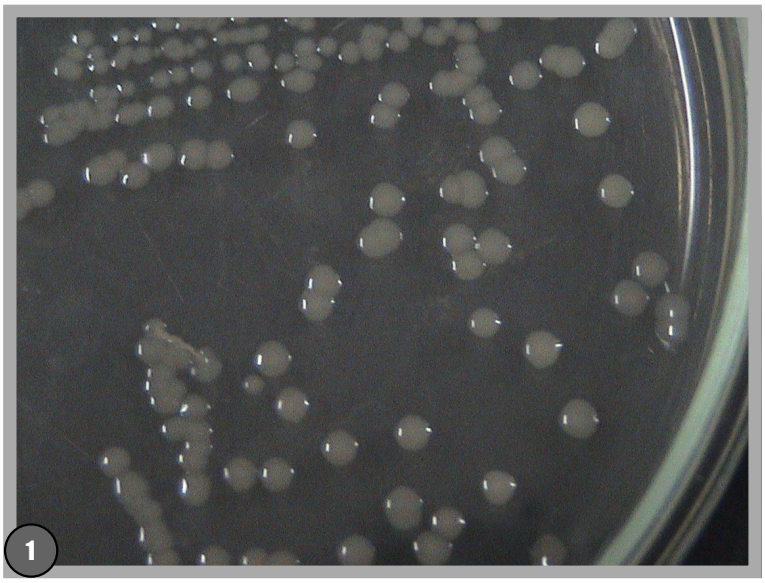
Lavilla-Pitogo CR, Marcial HS, Pedrajas SAG, Quinitio ET, Millamena OM. 2001. Problems associated with tank-held mudcrab (*Scylla* spp.) broodstock. Asian Fish. Sci. 14: 217-224

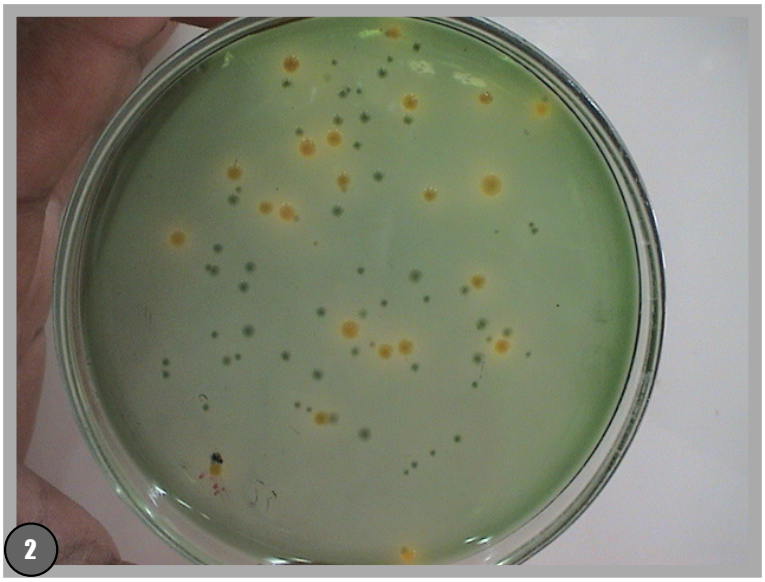
Sizemore RK, Colwell RR, Tubiash HS, Lovelace TE. 1975. Bacterial flora of the hemolymph of the bluecrab, *Callinectes sapidus*: numerical taxonomy. Appl. Microbiol. 29: 393-399

Scott JR, Thune RL. 1986. Bacterial flora of hemolymph from red swamp crawfish, *Procambarus clarkii* (Girard), from commercial ponds. Aquaculture 58: 161-165

## Web-based Resources

http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=240053 = this links to an article about bacteria associated with crabs in cold waters



# Gill Fouling with Debris

**Cause:**

The gills are very important for respiration and its function and location make it vulnerable to fouling with debris and suspended matter in the water. The prevalence of gill fouling varies with the preening activity and health status of the crab.

**Effect on Crabs:**

- Gill fouling is not a problem when water quality is good and dissolved oxygen content is optimum (> 5 ppm)
- Severe accumulation and build up of fouling organisms impairs water movement across the gills and can lead to suffocation

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Due to the opaque nature of the carapace (Appendix 10), gills can be observed only after lifting it off from the animal, thus the need to sacrifice them for examination
- In healthy animals, the sweeping movement of gill rakers or flabella (Photo 1 and 2; arrows) keep the gills clean

**Microscopic Examination (Level II):**

- Prepare specimens for microscopy (Appendix 3)
- Examine for presence of amorphous debris over the lamellae (Photo 3)

**Methods of Prevention and Control:**

- Keep rearing water clean and free from suspended particles that may clog the gills
- Avoid phytoplankton die-off since this contributes to clogging materials on the gills
- The normal motion of gill rakers or flabella keeps the gills clean in healthy crabs. In crabs where cleaning activity is ineffective, check underlying causes rather than providing temporary relief by curing the signs
- In cases where gill-cleaning structures are not effective against bacterial or ciliate fouling, molting should be induced to rid the crabs of heavy fouling organism build up

**References**

Bauer RT. 1999. Gill cleaning mechanisms of a dendrobranchiate shrimp, *Rimapenaeus similis* (Decapoda: Penaeidae): description and experimental testing of function. J. Morphol. 242: 125-139

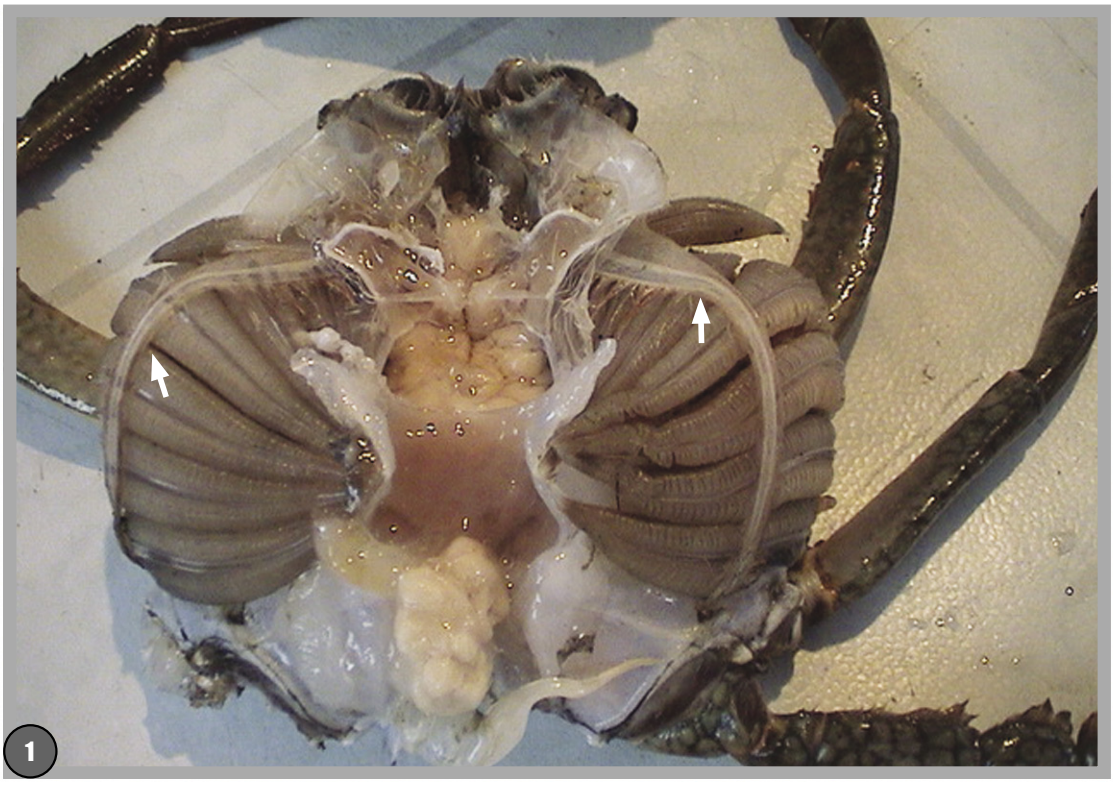
Lavilla-Pitogo CR, Lio-Po GD, Cruz-Lacierda ER, Alapide-Tendencia EV, de la Peña LD. 2000. Diseases of Penaeid Shrimps in the Philippines. Second Edition, Aquaculture Extension Manual No. 16. SEAFDEC Aquaculture Department, Iloilo, Philippines. 83 p

## Web-based Resources

http://www.usc.louisiana.edu/~rtb6933/shrimp/clean.html = shows interesting photos on cleaning behavior of shrimp

http://www.vims.edu/adv/ed/crab/guts3.html = shows an illustrated internal and external anatomy of a crab with an anatomical glossary

http://www.lander.edu/rsfox/310callinectesLab.html = a resource for the illustrated external and internal anatomy of the blue crab *Callinectes sapidus*, and notes on their functions. These should not be used as reference in the identification of mud crabs, *Scylla* spp.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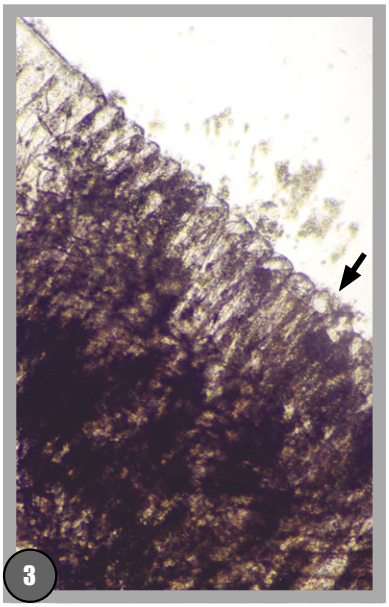
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# Algal Encrustation

**Cause:**

Encrusting green alga that is widely distributed in marine and brackish water environments

**Effect on Crabs:**

- Unknown

**Diagnostic Techniques:**

**Gross Observations (Level I):**

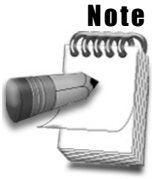
- Brown to greenish discoloration of the gills, especially at the distal portion (Photos 1-3)

**Microscopic Examination (Level II):**

- Prepare fresh mounts of affected gills for light microscope examination (Appendix 1)
- Green algal cells form sparse to dense greenish multicellular mats over the gill lamellae (Photos 4 and 5)

**Histology (Level II):**

- Fix gill tissues in Davidson's fixative or other formalin-based fixatives (Appendix 12)
- Observe for entrapped debris in between gill lamellae (Photo 6; H&E × 100) and dividing encrusted algae (Photo 7; arrows; H&E × 200)



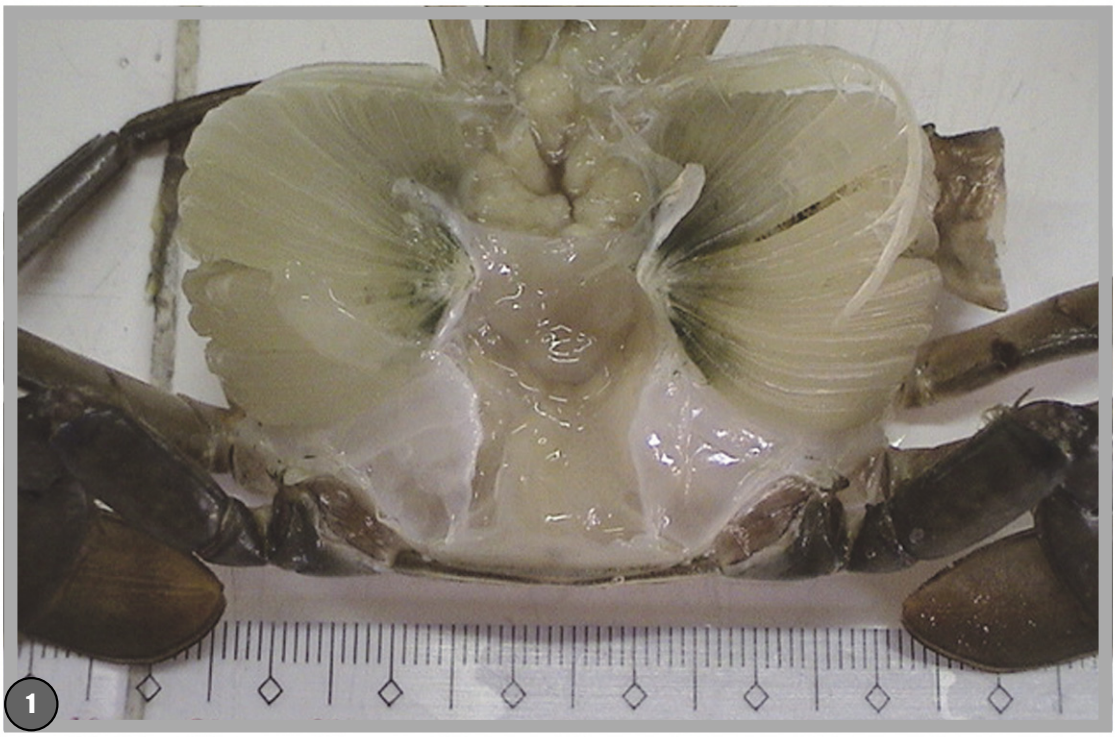

**The importance of histology:**

*In some cases, examination of well prepared histological slides from adequately fixed specimens gives insight on the status of affected tissues and the extent of damage.*

*For more information about histology, log-in to:* http://histology-world.com

**Methods of Prevention and Control:**

- Gill fouling is an outcome of poor water quality, thus improvement of water circulation and replenishment of clean rearing water may alleviate the condition
- Green algal encrustation is also a result of rearing crabs in waters with dense algal population, thus water change to thin out the algal load will remedy the condition
- Crabs should not be exposed to too much sunlight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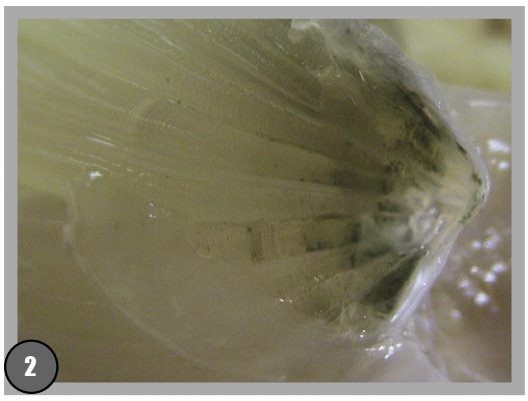
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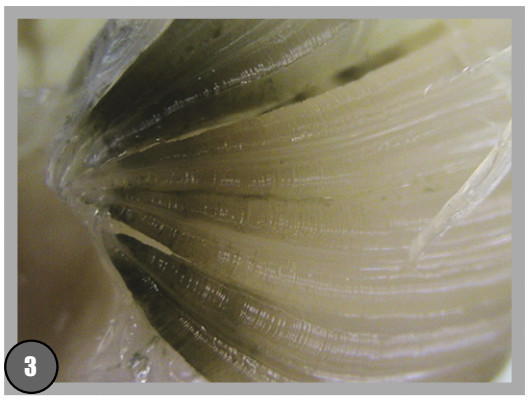
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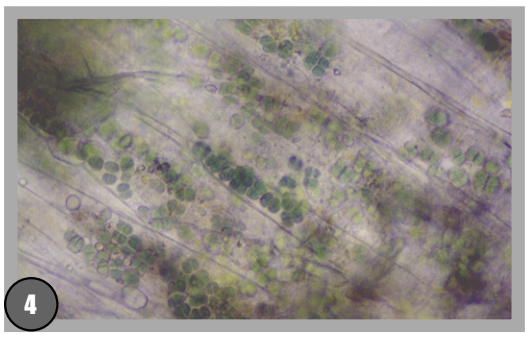
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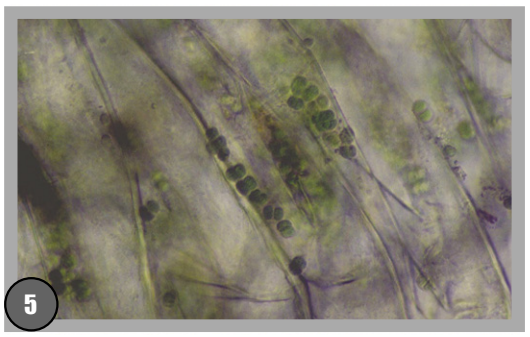
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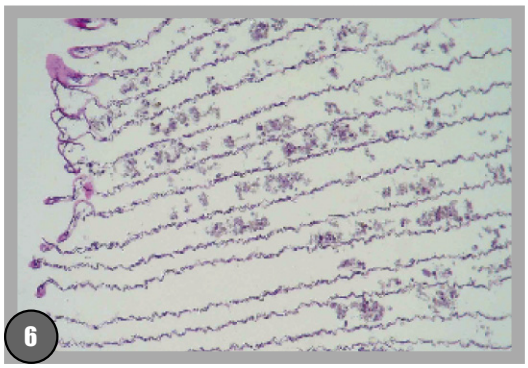
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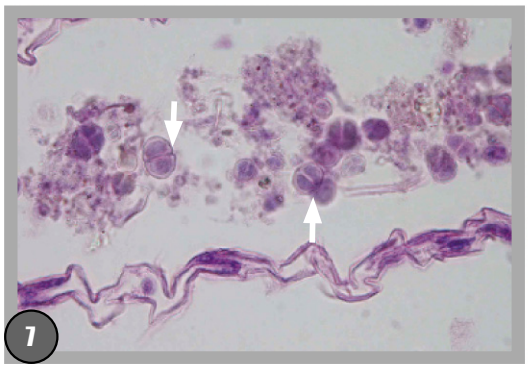
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# Gill Commensals and Parasites

Stalked barnacles, which are morphologically similar to *Octolasmis* spp. were observed around the carapace at the edge of the inhalent aperture, at the base of the cheliped, and on the second and third maxillipeds (Photo 1; arrows). They are also lodge on the gills (Photos 2-4).

**Pathogen or Cause:**

Various types of barnacles such as *Octolasmis cor*, a stalked barnacle. Barnacles are widely distributed in marine and brackish water environments and colonize many types of submerged surfaces.

**Effect on Crabs:**

- Larval stages of the barnacle *Octolasmis* may colonize the gill chambers in the debilitating numbers
- The magnitude of infestation on individual crabs increases with their size
- The prevalence of *Octolasmis cor* is significantly higher in female crabs than in males.
- The stalked barnacles that inhabit the respiratory chambers occupy the space on the gills normally available for oxygen and carbon dioxide exchange
- Some of the negative effects of *Octolasmis* infestation are competition for oxygen or blockage of the gills due to accumulation of debris on colonized respiratory surfaces

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Presence of stalked organisms on the gills, around the carapace at the edge of the inhalent aperture, at the base of the cheliped, and on the second and third maxillipeds (Photos 1-4)

**Methods of Prevention and Control:**

- Unknown

## References

Hudson DA, Lester RJG. 1994. Parasites and symbionts of wild mud crabs *Scylla serrata* (Forskal) of potential significance in aquaculture. Aquaculture 120: 183-199

Jeffries WB, Voris HK, Poovachiranon S. 1992. Age of the mangrove crab *Scylla serrata* at colonization by stalked barnacles of the genus *Octolasmis*. Biol. Bull. 182: 188-194

Jeffries WB, Voris HK, Yang CM. 1985. Growth of *Octolasmis cor* (Aurivillius, 1892) on the gills of *Scylla serrata* (Forskal, 1755). Biol. Bull. 169: 291-296

Jeffries WB, Voris HK, Yang CM. 1989. A new mechanism of host colonization: pedunculate barnacles of the genus *Octolasmis* on the mangrove crab *Scylla serrata*. Ophelia 31: 51-58

Lavilla-Pitogo CR, Marcial HS, Pedrajas SAG, Quinitio ET, Millamena OM. 2001. Problems associated with tank-held mudcrab (*Scylla* spp.) broodstock. Asian Fish. Sci. 14: 217-224

Overstreet RM. 1978. Marine maladies? Worms, germs, and other symbionts from the northern Gulf of Mexico. Mississippi-Alabama Sea Grant Consortium, Sea Grant Publ. No. MASGP-78-021, Mississippi, USA. 140 p

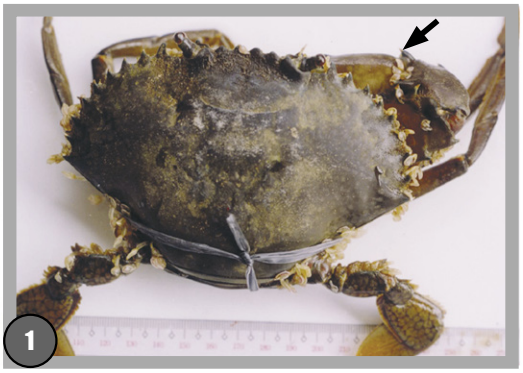
Overstreet RM. 1988. Aquatic pollution problems, Southeastern U.S. coast: histopathological indicators. Aquatic Toxicol. 11: 213-239

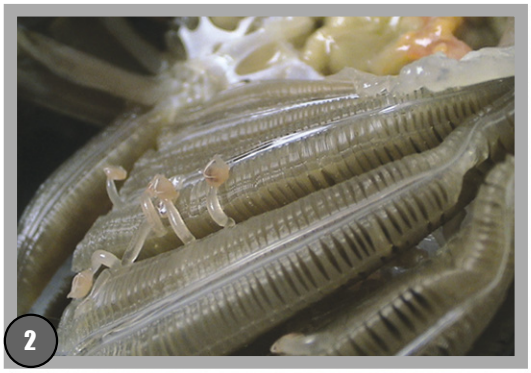
Voris HK, Jeffries WB, Poovachiranon S. 1994. Patterns of distribution of two barnacle species on the mangrove crab, *Scylla serrata*. Biol. Bull. 187: 346-354

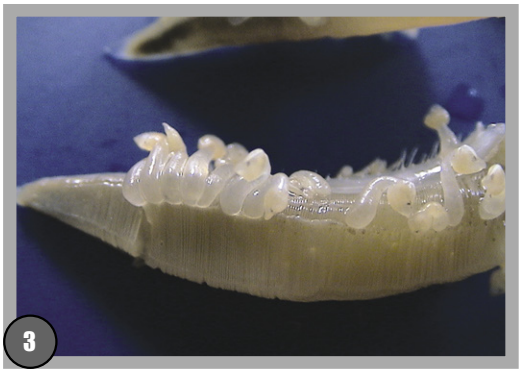
## Web-based Resources

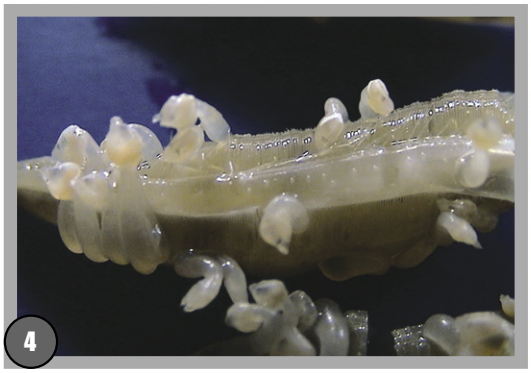
www.crustacea.net/index.htm = this site offers leads regarding crustacean taxonomy

http://www.fathom.com/feature/121900/ = this site provides information about types of barnacles, including parasitic ones



# Gill Discoloration

Gray, brown to black discoloration of gill arches can occur in pond-cultured crabs (Photo 1).

**Cause:**
- Environmental failure due to improper pond preparation and accumulation of organic load due to uneaten and excess feed
- Poor environmental condition due to inadequate water exchange
- Heavy siltation

**Effect on Crabs:**
- Respiratory stress or failure due to clogging of gill surfaces
- Prolonged exposure to primary cause may lead to general weakness and onset of secondary infection by bacteria, fungus, and protozoans
- Loss of appetite
- Mortality

**Diagnostic Techniques:**

**Gross Observations (Level I):**
- Discoloration usually starts at the tips
- Gray, brown to black discoloration of gill arches (Photo 1)
- Complete blackening of the entire gill system (Photo 2)
- Observation can only be done by sacrificing suspected animals

**Methods of Prevention and Control:**
- Remedy siltation and other causes of debris and sediment suspension in the water
- Correct soil pH prior to start of culture
- Submit soil samples for analysis (Appendix 11)
- Avoid overfeeding
- Provide adequate means for water change

## References

Lavilla-Pitogo CR, Lio-Po GD, Cruz-Lacierda ER, Alapide-Tendencia EV, de la Peña LD. 2000. Diseases of Penaeid Shrimps in the Philippines. Second Edition, Aquaculture Extension Manual No. 16. SEAFDEC Aquaculture Department, Iloilo, Philippines. 83 p

## Web-based Resources

http://www.lander.edu/rsfox/310callinectesLab.html = this site shows the internal and external anatomy of the blue crab *Callinectes sapidus*

http://aquanic.org/publicat/usda_rac/efs/ctsa/126.pdf = this site provides information on the prevention of gill blackening in cultured shrimps

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# Blackened Ovaries

Broodstock in tanks were fed various artificial diets for at least 3 months. After the experiment, crabs showed various ranges of ovarian discoloration ranging from orange with black spots to black with remaining orange spots (Photo 1).

**Cause:**

Blackened tissues or the appearance of black spots on crustaceans have mostly been associated with deposition of the pigment melanin as a result of mechanical or microbial injury. Blackened tissues have been reported in shrimp fed artificial diets with little or no Vitamin C.

**Effect on Crabs:**

- May affect fecundity among females
- Causes spawning failure or incomplete spawning
- If the cause of blackening is Vitamin C deficiency, it may also be a manifestation of poor disease resistance or weakening

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Blackening or discoloration of ovaries (Photos 1a,b,c). Normal ovary with developing eggs are orange in color (Photo 2)

**Histology (Level II):**

- Presence of blackened and blood-infiltrated tissues of the ovary (Photos 3-5; arrows; H&E × 200)

**Methods of Prevention and Control:**

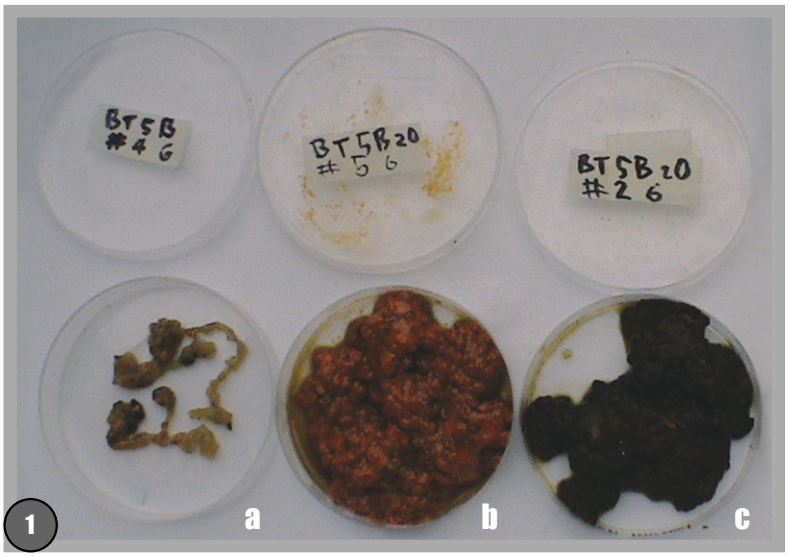
- Give crabs adequate and properly stored diets
- Ensure that Vitamin C sources are available in the diet or from natural food

## References

Lightner DV, Colbin LB, Brandt C, Danald DA. 1977. Black death, a disease syndrome related to a dietary deficiency of ascorbic acid. Proc. World Maricult. Soc. 8: 611-623

Djunaidah IS, Wille M, Kontara EK, Sorgeloos P. 2003. Reproductive performance and offspring quality in mud crab (*Scylla paramamosain*) broodstock fed different diets. Aquacult. Internat. 11: 3-15

Millamena OM, Quinitio ET. 2000. The effects of diets on reproductive performance of eyestalk ablated and intact mud crab *Scylla serrata*. Aquaculture 181: 81-90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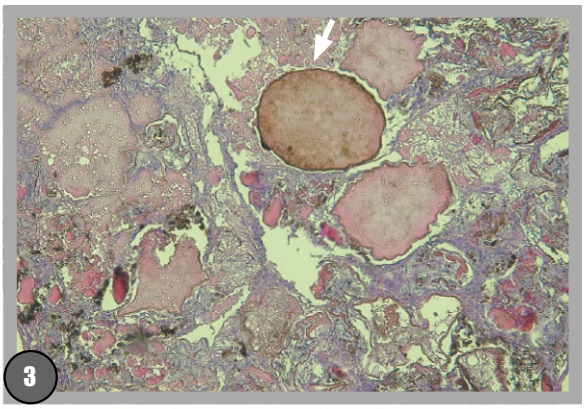
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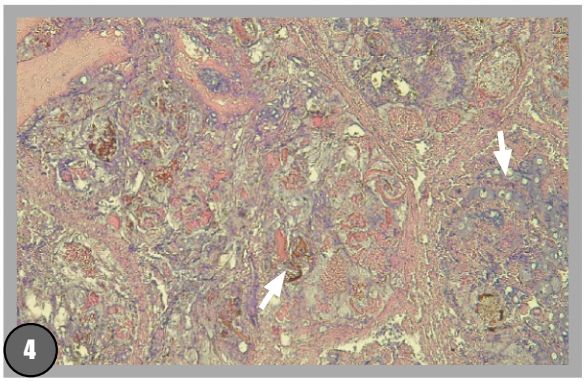
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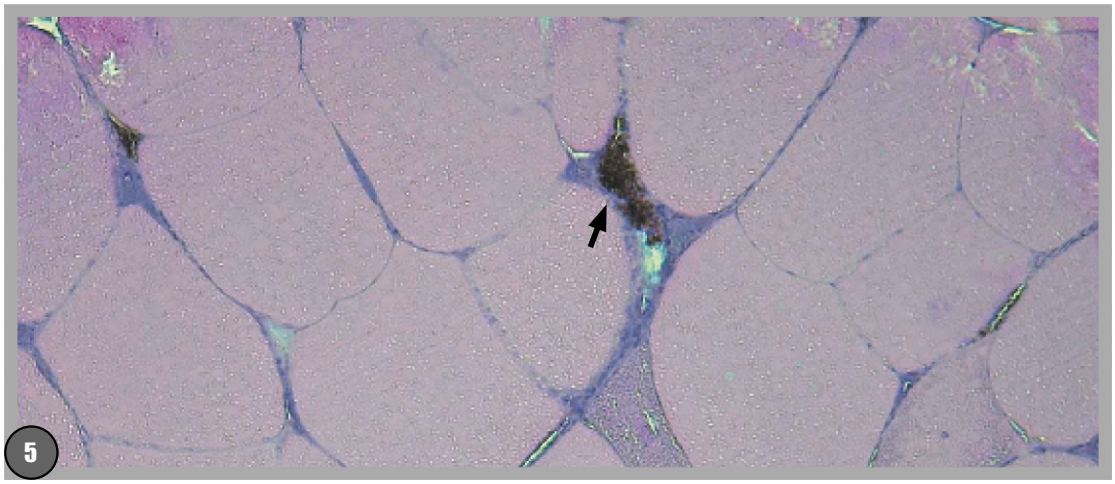
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# Egg Loss

**Cause:**

During incubation of eggs at optimum temperature range of 27 – 29.5°C, hatching normally occurs 9 – 14 days after spawning. However, due to failed fertilization, nutritional deficiency, microbial infection, heavy infestation with fouling organisms, and environmental stress, eggs fall off from the egg mass prior to hatching.

**Effect on Crabs:**

- Lowers fecundity and decreases number of larvae for rearing
- Causes spawning failure or incomplete spawning

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Egg mass changes from bright orange (Photo 1) to gray (Photo 2) without hatching a few days after spawning
- Eggs fail to develop into the next stage
- Eggs fall off gradually from the egg mass

**Microscopic Examination (Level II):**

- Fresh mounts of eggs show no "eyed" stage among incubating eggs in the sponge

**Methods of Prevention and Control:**

- Ensure that females are mated upon procurement or purchase
- Berried females should be kept in clean water during egg incubation to prevent microbial infection and fouling
- Spawners may be disinfected in 150 ppm formalin for 30 minutes to get rid of fouling organisms and fungi. This is especially for females who already have spawned upon procurement
- Broodstock that have not spawned should be separated from berried females to prevent cross-infection
- During egg incubation, 0.1 ppm Treflan can be applied to the water every 2 days

**References**

Djunaidah IS, Wille M, Kontara EK, Sorgeloos P. 2003. Reproductive performance and offspring quality in mud crab (*Scylla paramamosain*) broodstock fed different diets. Aquacult. Internat. 11: 3-15

Millamena OM, Quinitio ET. 2000. The effects of diets on reproductive performance of eyestalk ablated and intact mud crab *Scylla serrata*. Aquaculture 181: 81-90

Quinitio ET, Parado-Estepa FD. 2003. Biology and Hatchery of the Mud Crabs *Scylla* spp. Aquaculture Extension Manual No. 34, SEAFDEC Aquaculture Department, Iloilo, Philippines. 42 p

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# Incomplete Molting

Crustaceans shed their exokeleton through a process called molting or ecdysis. This procedure is necessary for growth and requires a lot of energy to accomplish. Where conditions for complete molting are not met, affected animals fail to shed off their old shells completely resulting to parts of the old shell to remain attached to the new shell. Molting in crustaceans should not be prolonged so as not to reach a point-of-no-return, after which molting will never occur.

**Cause:**

- The factor mostly implicated with the occurrence of incomplete molting is low temperature and nutritional causes
- In one experiment, 37% of crab juveniles reared at ambient temperature (27-30°C) successfully molted during the 30-day holding period, but only 17% of crabs at 20-22°C molted in the same period

**Effect on Crabs:**

- Attached old shells cause abnormal movement or swimming behavior and affected crabs become easy prey to healthy individuals

**Diagnostic Techniques:**

**Gross Observations (Level 1):**

- Presence of old shell attached to newly-molted exoskeleton (Photo 1; arrow) in contrast to complete shedding of exoskeleton during successful molting (Photo 2; arrow)
- Note the size increment after molting

**Methods of Prevention and Control:**

- Give crabs adequate diet to provide energy for successful molting
- Grow crabs at optimum water temperature (Appendix 9)

**Web-based Resources**

http://ourworld.compuserve.com/homepages/BMLSS/Ecdysis.htm


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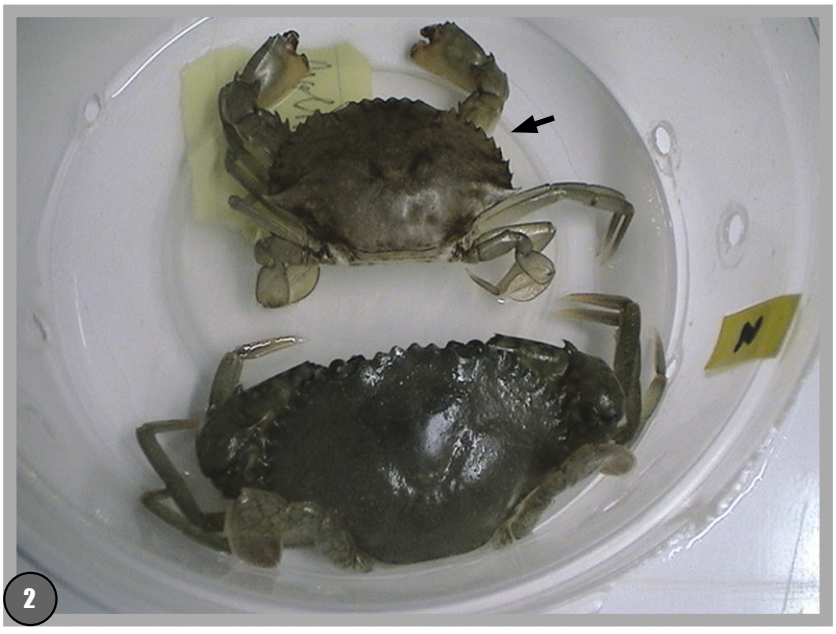
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# Loss of Limbs

**Description:**

Crabs sacrifice their limbs through the process of autotomy in order to escape from predators. Other factors that have been ascribed to appendage loss in various species of crabs include too much exposure to dry environment and physical stress due to traumatic molt. Crabs are very aggressive animals and often suffer injury and loss of limbs (Photo 1). Severe muscular emaciation of some captive broodstock may result in the loss of limbs (Photo 2; arrow). Regeneration of the lost part, if it occurs, does not restore its original function because of the relatively small size of the new appendage (Photo 3; arrow). In cases where only one appendage is lost, the crab will have chelipeds with different sizes (Photo 4; arrow).

**Effect on Crabs:**

- The loss of a major appendage like the cheliped may lead to impaired feeding, mating, and capability for defense. A study done on spanner crabs showed that limb damage significantly affected survival, but not their ability to bury themselves and hide from predators.

**Diagnostic Techniques:**

**Gross Observations (Level I):**

- Absence of appendages (Photos 1 and 2)

**Methods of Prevention and Control:**

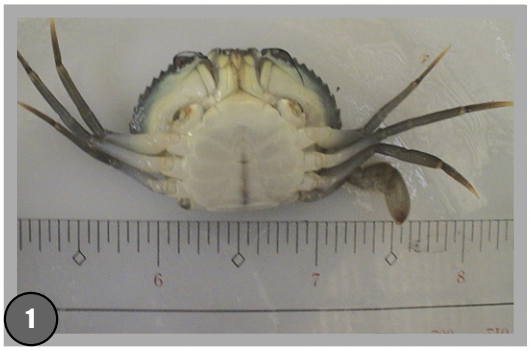
- Provide shelters to prevent aggressive behavior that might lead to fights and loss of appendages
- Maintain good conditions in the rearing tank to keep crab healthy in captivity
- Provide proper nutrition to prevent emaciation
- Avoid too much exposure to dry environment

## References

Kirkwood JM, Brown IW. 1998. Effect of limb damage on the survival and burial time of discarded spanner crabs *Ranina ranina* (Linnaeus). Mar. Freshwat. Res. 49: 41-45

## Web-based Resources

http://www.blue-crab.org/autotomy.htm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